

Analysis of Open Science Policy Recommendations Proposed in India's 5th Science, Technology & Innovation Policy Draft

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Executive Summary: One of the core principles of science is to aid socio-economic growth. Open science is a movement that reinforces the primacy of science in the direction of economic and social welfare. UNESCO's recommendation on open science aims to provide an international framework for open science policy and practice. It endorses unrestricted access to scholarly publications and data, the use of digital technologies to drive scientific processes, more collaboration and cooperation among the actors in the scientific ecosystem, sharing of research infrastructure, acknowledgment of diverse knowledge systems, and science for society. Open science could enable a productive science ecosystem in global south countries through efficient knowledge circulation, resource sharing, and collaboration. Analysis of open science policy from a global south country can provide valuable insights. India is preparing to adopt an open science framework recommended in the 5th Science, Technology, and Innovation Policy (STIP) draft, released in December 2020. The STIP draft recommends open access to articles and research data from publicly funded projects, access to research infrastructure beyond the boundary of academic and research institutions, strengthening of Indian journals, and open educational resources. However, the draft lacks an exhaustive implementation plan. The draft falls short in devising strategies to foster collaboration between actors of the STI ecosystem, the inclusion of traditional knowledge systems, and society's role in knowledge creation processes. The science policymakers and advisers of the Department of Science and Technology and the government of India should probe these areas to develop a more effective and inclusive open science framework.

I. Brief introduction to open science: background, practices, and relevance

The global population is facing massive challenges, such as climate change, food security, energy security, health, nutrition, and access to clean water. In 2015, the United Nations launched an agenda of 17 Sustainable Development Goals (SDGs) to be realized before 2030 (UN SDGs 2015). These goals are complex and interconnected, entailing a more efficient global STI ecosystem capable of providing innovative solutions. Addressing them in isolation of academic institutions is impossible and will require multidisciplinary and multi-stakeholder approaches, skill sets, and resources. However, quality ideas and outcomes from scientific research are not growing as

fast as the investment in STI, resulting in a decline in innovation (Bhattacharya and Packalen 2020, w26752) (Bloom et al. 2020, 1-45). To increase the productivity of the STI ecosystem, we need more openness, collaboration, and sharing among the stakeholders—more conclusively, we need open science.

The origin of open science dates to the Middle Ages when it played a vital role in the scientific revolution (David 2007). Open science is now a growing movement to make science accessible. One way to define “open science is an umbrella term for many assumptions about how the future of knowledge creation and dissemination (as well as education)

will work” (Fecher and Friesike 2014, 17-47). Open science supports creating a vibrant community that extends beyond the walls of scientific organizations and disciplines and expands the societal impact of science (UNESCO Open Science Report 2021). OECD has published numerous research studies that provide concrete evidence on the relevance of open science (OECD 2015). If nothing else, the COVID-19 pandemic has helped stakeholders in the science-ecosystem system realize the fallacy of current practices and the need for open science.

The United Nations Educational, Scientific and Cultural Organization (UNESCO) has compiled recommendations from extensive global consultation and experts from about 100 member states to promote open science. The UNESCO Open Science Framework (UNESCO 2021) was adopted at the General Conference of UNESCO in Paris in November 2021. This framework emphasizes expanding the processes of scientific knowledge creation, evaluation, and communication, recognizes the importance of collaborative R&D with global co-authors, and promotes more inclusive, transparent practices.

The knowledge, access, and funding divides put researchers of global south countries at a disadvantage. Open science can be a valuable tool to diminish the inequalities between countries. In this context, it will be helpful to analyse a proposed open science policy from a global south nation. Such an analysis will provide insights into open science implementation strategies and mechanisms from a low- and middle-income country perspective. India has already started integrating open science principles into their STI ecosystem. It defines open science as a measure to foster collaboration and cooperation among scientists and other social actors through seamless access to research articles, data, and research infrastructure to promote rapid and inclusive innovation. This article aims to understand the proposed policy instruments and implementation strategies devised by the Indian policymakers to encourage the adoption of open science in the Indian STI ecosystem. How is the country creating a roadmap to foster better access to knowledge and recourses? What are the roadblocks to the implementation of open science? What are the possible apprehensions in moving toward an open science ecosystem? Most importantly, what is the

sustainability of the open science ecosystem in the long run? Such an analysis will help understand the priorities and challenges in open science in the global south context.

II. Status of open science in India: policies, practices, and infrastructure

Indian science policy makers acknowledge the importance of open science. There are existing policies and infrastructure in place to promote open science (Figure 1). It started with the articulation of several policies like the Data sharing policy (2012), the Open Access Policy (2014), the SHRIMAN Guideline (2022) for sharing of research infrastructure, and the draft Biological Data Storage, Sharing and Access Policy (2019). Initiatives like SATHI and iSTEM are two approaches launched by the Department of Science and Technology and Office of Principal Scientific Adviser to the Prime minister, respectively, to promote sharing of research infrastructure. Additionally, there are several publicly funded digital infrastructures, such as NPTEL (open educational platform), NDLI (digital library project), and Shodhganga (repository of Ph.D. and Masters’ theses), categorized under open educational resources. The following list details the directives and roles of other existing open science initiatives.

- National Data Sharing and Accessibility Policy, (NDSAP) 2012: This policy directs government departments to proactively provide all the shareable data and information created, generated, collected, and archived using public funds. This policy was primarily focused on government data. Understandably, this mandate lacks clarity on several terms such as user community, types of data, and accessibility where research data is concerned. The limitations of NDSAP (NDSAP 2012) are being resolved through the open data policy for publicly funded research of Science, Technology, and Innovation Policy (STIP).
- DBT and DST Open Access Policy on open access to DBT and DST funded research, 2014: The Department of Biotechnology (DBT) / Department of Science and Technology (DST) created the Open Access policy requiring researchers to disclose the full text of final accepted manuscripts, associated metadata, and supplementary

material created through DBT/DST funding in open repositories. This policy is yet to be evaluated.

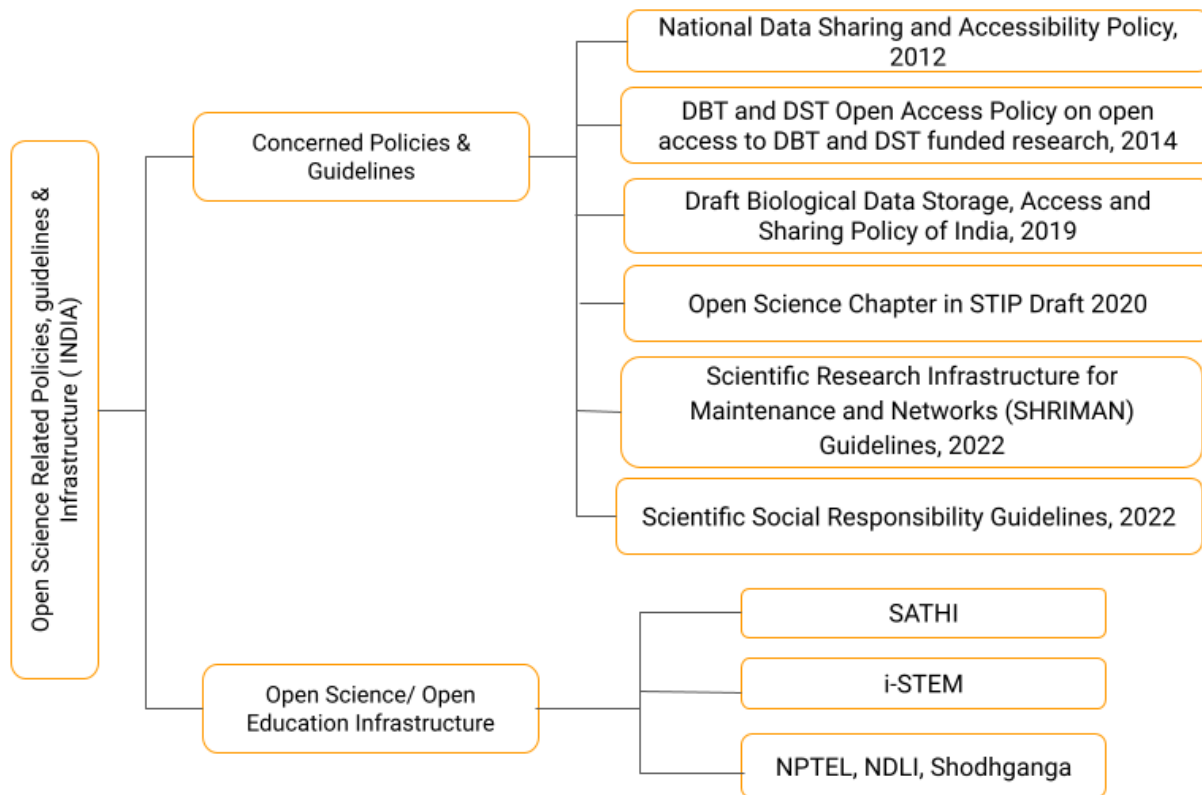


Figure 1: Overview of existing open science policies and infrastructures in India.

- Draft Biological Data Storage, Access and Sharing Policy of India, 2019: To facilitate access to data created from publicly funded biological research, a draft policy (DBT 2019) has been formulated that is still in the pipeline for processing.
- Scientific Research Infrastructure for Maintenance and Networks (SRIMAN), 2022: SRIMAN guidelines are the leading document to guide the infrastructure sharing principles and are a vital addition to the open science policy paradigm beyond digital infrastructure sharing.
- Scientific Social Responsibility Guidelines, 2022: In May 2022, the Government of India (GOI) issued a formal guideline of Scientific Social Responsibility (SSR 2022). Scientific Social responsibility refers to the commitment of researchers and innovators towards the societal relevance and impacts of their research activities as the ethical outcomes of their research. The GOI formulated the SSR

guideline with a vision to uphold the role of science for global well-being and to ensure effective and ethical communication of science to society.

Despite these policies and initiatives, Indian researchers are yet to adopt open science practices. India is planning to support a culture of open science by formulating a new STIP (STIP 2020). This is the 5th STI policy of the country after independence in 1947 and the draft is awaiting cabinet approval. The draft STIP recognizes open science as an essential element for achieving a productive STI ecosystem that can accelerate the progress of attaining SDGs.

III. Open science in 5th STIP draft: insights and analysis

India's 5th STIP draft recognizes open science as an essential element for the STI ecosystem of the country. Like many countries, discussions around the effectiveness of current practices of science in India started with the debate of access to

knowledge-accessing journal articles locked behind the paywall of publishers. This section briefly outlines the policy instruments proposed in the 5th Indian national STIP draft and their roles in strengthening and harnessing an open science framework for the academic R&D ecosystem in India.

The Indian open science vision, proposed in the 5th STIP draft, is a conceptualization of the global definitions and perceptions of open science with an emphasis on local needs. This framework recognizes global issues like enhanced availability of open data from publicly funded research and open access as two essential pillars. It also acknowledges local needs, such as sharing research facilities, improving the quality of Indian journals, enhancing access to libraries and open learning spaces, open educational materials, and creating digital infrastructures for facilitating open science practices. Fundamentally, the framework proposes a “better integration of science and society, recognition of traditional knowledge systems, and more equitable participation of various stakeholders” in scientific endeavours. Outside the open science framework, the STIP draft also acknowledges the importance of science communication and citizen science. The following list provides the recommended policy instruments (Figure 2) for the facilitation of open science practices in the Indian STI ecosystem.

- Open data policy for publicly funded research: The STIP draft recommends that researchers should deposit data used in and generated from their publicly funded research projects to a designated repository. This will ensure that data will be available to everyone (larger scientific community and public) under FAIR Principles. This policy targets cultivating data-driven discoveries.
- Open access: Researchers generally publish their works through journal articles. In most cases, these articles are behind the subscription paywall of commercial publishers. The research community cannot access them without an institutional subscription or purchase of an article. To ensure that research outputs from publicly funded projects are available, the draft STIP recommends that post-prints and optionally preprints of published articles generated from publicly funded projects and

supplementary materials should be deposited to an institutional or central repository immediately upon acceptance by the journal.

- One nation, one subscription: Many academic and research institutions in India do not have access to necessary journals since the subscription costs are too high. To ensure all publicly funded institutions have required access to journal articles, the GOI has devised a “one nation, one subscription” policy. According to this proposed policy, the GOI will negotiate with journal publishers to facilitate access to journals for all academic institutions in the country through a central payment system.
- Indian journals: Indian science academies publish many journals that are open access and do not charge publication fees. However, researchers do not publish their good works in these journals since they do not have an international reputation or good impact factor. Moreover, the editorial and the peer review process are not satisfactory. STIP draft recommends upgradation of the quality and visibility of Indian journals.
- Research facilities: The STIP draft recommends that publicly funded scientific resources such as research infrastructures, laboratory facilities and instruments, ICT and AI resources, and high-performance computing facilities should be shareable and accessible to scholars nationally. This way, researchers from institutions where such facilities are not available will be able to access the required research facilities to conduct their research.
- Open educational resources: The STIP draft recommends that publicly funded open education resources should be made widely accessible through digital platforms under minimally restrictive open content license, with the right of attribution preserved and translations permitted. This is intended to reduce the gaps in accessing educational knowledge due to financial inequalities.
- Libraries: The draft STIP aims to democratise access to knowledge. Facilitating access to libraries at publicly funded institutions and expanding the public library system is a step toward this goal.

- Learning spaces: Collaboration and cooperation is the central idea of open science. The recommendation of making learning spaces, including conference rooms and other infrastructure, universally accessible based on international guidelines and standards, supports this objective.

The draft policy document also suggests possible infrastructural and governance set-ups that can guide and facilitate the adoption of open science practices with a long-term vision. The two crucial recommendations in this direction are:

- Setting up an open-access portal, Indian Science and Technology Archive of Research (INDSTA), to provide access to the outputs of all publicly funded research. This portal will provide substantial storage space to host data and facilitate flexible text and data mining, querying, and visualization.
- Setting up a national STI observatory as a central system to oversee the STI activities in the country. The STI observatory is recommended to be responsible for but not limited to conducting analyses of projects, funding, outcomes, technological capabilities, Technology Readiness Levels and Business Readiness Levels (TRLs & BRLs), talent mapping, and establishing evaluation, accreditation, ranking, and rating protocols for benchmarking.

IV. Discussion

The proposed Indian open science framework aims to democratize science. It focuses on building an inclusive, transparent, and efficient science ecosystem globally based on a few shared principles. The recommendation on “one nation, one subscription” points out the good political intent and alignment of top scientific leaders of the country toward the open science vision. While the recommendations are aligned with UNESCO’s open science discourse, there remain gaps in knowledge production. Most recommendations in the draft STIP focus primarily on the knowledge dissemination or

output side. This understanding of open science in India is similar to most global conversations about open science. Knowledge dissemination receives immediate attention with little or no contemplation of the knowledge creation process. The cultural diversity in knowledge production and integration of various knowledge systems do not receive due consideration in the Indian open science conversation. Indian open science dialogue must devise ways to make the knowledge creation process more inclusive and collectively governed by society. Open science partnerships between societal agents and science institutions are essential for achieving directed knowledge creation for accomplishing SDGs.

By design, open science and intellectual property represent two conflicting ideas: knowledge as a shared public good, and commercialization of STI-driven knowledge products. There is no effort in the draft STIP to balance this discord. The Indian open science framework must acknowledge the need for proper incentive structures for researchers that will devalue the impact factor and publication-driven science and promote societal need-driven science. Other challenges are the lack of institutional and human capacities and administrative hurdles. At this stage, implementing and realizing the Indian open science goals requires stakeholder participation, capacity building, and investments in open science infrastructure.

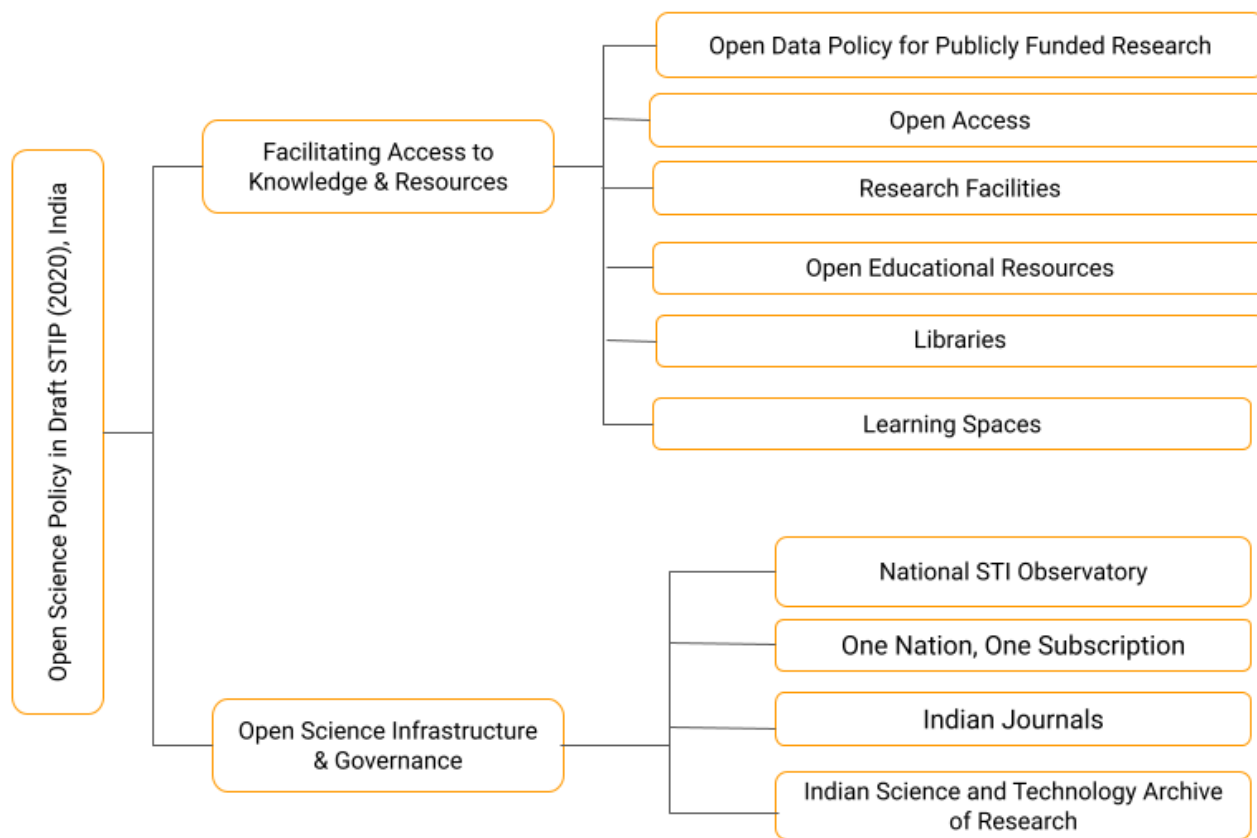


Figure 2: Recommended open science policy instruments in India's 2020 Draft STIP 2020. The upper section includes recommendations that foster seamless access to knowledge and resources for conducting research. The bottom section illustrates how these recommendations will be implemented.

V. Challenges in implementation

The GOI wants to negotiate with prominent scientific publishing entities to initiate a nationwide journal subscription model replacing the individual institution-based agreements (one nation, one subscription policy). Only two countries worldwide, Uruguay and Egypt, have implemented similar agreements, but on a much smaller scale (Sinha, 2020). Therefore, the question remains regarding the operational success of such an ambitious project, especially when the terms, conditions, and accomplishments of the previous two examples are unclear. Moreover, with the rise of open-access publishing, where many journals operate through an author pay model, the applicability of a subscription-only deal is questionable.

The draft STIP also proposes improving the quality and visibility of Indian journals, funded by the GOI and hosted by the Indian science academies. However, it does not provide any roadmap for implementing this policy. These journals have

existed for a long time but have never been able to attract high-quality research articles from scholars. Publications in these journals also do not get proper recognition in the Indian academia.

Stimulating collaboration and cooperation in the STI ecosystem, not just among the researchers but with society, is one of the crucial recommendations of open science. However, the draft STIP does not provide directions to nurture such an ecosystem.

VI. Recommendations

As open science is also about inclusiveness and broader participation in science, it is imperative to ensure that the recommendations also explore including diverse knowledge systems and involving society in the knowledge creation process. Policymakers and funders can promote more citizen science and participatory research projects to bring non-scientists and scientists together in knowledge creation. Such measures will ensure inclusive participatory science. Moreover, voices from society

can be heard in concerns like ethics in AI or data privacy of individuals.

Open science demands effective implementation of the right to research and education. To ensure the right to research and education, there needs to be a better emphasis on limitations and exceptions to the rights provided under different IP laws, including copyright law and patent law. Open educational resources are a great way to ensure the right to education and research. There are initiatives like NPTEL, which is an e-learning platform that hosts free online courses, and NDLI from the GOI to re-enforce access to educational resources. Still, content availability is insufficient and needs expansion. There are contradictions between the idea of open science and intellectual property rights, and balance is needed. The extent that publicly funded research can be appropriated by individuals and institutions needs clear guidelines.

The draft STIP must help reorient priorities in research assessment to foster open science practices. Quantitative metrics such as Journal Impact Factor (JIF), h-index, and other such metrics play the most prominent role in assessing the impact of academic research. However, such measures incentivize researchers to engage in incremental research and publish many research articles but fail to create socially relevant or transformative scientific research. We need to develop a more holistic and responsible research assessment system that focuses on incentivizing and rewarding high-quality research within diverse and inclusive research cultures.

Investments in open science infrastructure, capacity building, guidelines and sharing standards of data and data security, and knowledge governance are a few of the pressing challenges and need clearer strategies for successful adoption of open science practices. Fostering access to knowledge and resources will need investment in infrastructure through which researchers can access research data. Development of a comprehensive data governance framework is also essential to tackling issues of data security, proper attribution, and data standardization.

Traditional knowledge systems, such as Ayurvedic medicine, Yoga, and traditional agricultural practices are integral parts of society in India. Scientists

usually discredit these knowledge systems as unscientific. The UNESCO open science recommendations promote interactions between various knowledge systems with science; this should be integrated into the proposed open science framework of India.

Makerspaces are imagining new ways of inclusive innovation through collective knowledge and open licences. Promotion of such open innovation cultures through the draft STIP will encourage innovation outside academic institutions and private enterprise.

VII. Conclusions

The need to adopt open science to channel the efforts of scientists and scientific enterprises toward achieving socio-economic growth is undeniable. Open science is a powerful tool that can ensure the equitable participation of all stakeholders in scientific enterprises. To achieve the true potential of open science, besides facilitating access to knowledge, data, and resources, the Indian academic ecosystem also needs to develop their collaboration and cooperation. Currently, the collaboration, especially international collaboration with global south countries, is lacking in India and requires correction. Knowledge co-creation with society is another challenge. Additionally, Indian science agencies should invest in upgrading the infrastructures to provide state-of-the-art facilities for repositories (for publication and data), ensuring interoperability with existing infrastructures both globally and locally. To achieve the policy goals, open science-policy directives should consider sustainable infrastructure, data governance structure, technical and subject-specific standards, ownership, and human capacity development. Most importantly, policymakers should not compel the actors of the Indian STI ecosystem to align with the open-science ideas. Rather, informing them about the benefits of open science through proper communication channels would work better.

Open science could enable an efficient science ecosystem in India through efficient knowledge circulation among the actors of the STI ecosystem. It could stimulate the creation of an inclusive environment to assimilate various knowledge systems and foster both local and international collaborations. Such a system would drive innovations to meet the targets of SDGs.

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